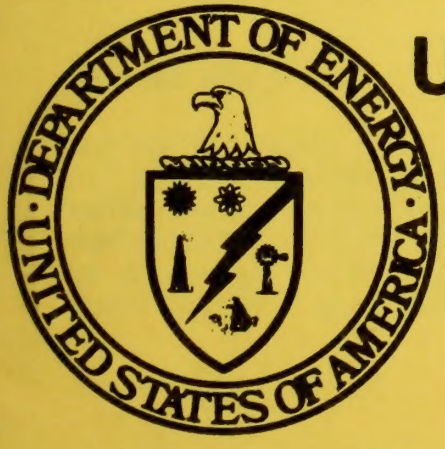
SOLAR/1039-79/04

Monthly Performance Report

SADDLE HILL TRUST

LOT 73

APRIL 1979



U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

MONTHLY PERFORMANCE REPORT

SADDLE HILL TRUST
LOT 73

APRIL 1979

I. SYSTEM DESCRIPTION

Saddle Hill Trust Lot 73 is a single-family residence in Medway, Massachusetts. Solar energy is used for preheating incoming city water. The system has an array of flat-plate collectors with a gross area of 45 square feet. The array faces south at an angle of 45 degrees to the horizontal. A 60 percent glycerol solution is used as the medium for delivering solar energy from the collector array to storage. Water is the transport medium that delivers solar energy to storage and to the domestic-hot-water (DHW) heater. Solar energy is stored in the basement in an 80-gallon preheat tank. This preheated city water is supplied, on demand, to a conventional 40-gallon DHW tank. When solar energy is insufficient to satisfy the hot water requirements, the gas-driven DHW heater provides auxiliary energy for water heating. The system, shown schematically in Figure 1, has two modes of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when a 40°F temperature difference exists between the collector and the preheat tank. Pump P1 is on. This mode continues operating until the temperature difference drops to 20°F.

Mode 2 - Storage-to-DHW Tank: This mode activates when there is a demand for hot water. Hot water from the top of the preheat tank is transferred to the DHW tank to replace the amount removed. Simultaneously, city water is automatically supplied to the preheat tank.

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was occupied in April and the solar energy system operated continuously during the month. Solar energy satisfied 45 percent of the DHW requirements. The solar energy system incurred an electrical energy expense of 0.14 million Btu and provided a fossil fuel energy savings of 1.1 million Btu.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 1.7 million Btu for a daily average of 1244 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during April of 1334 Btu per square foot for a south-facing plane with a tilt of 45 degrees to the horizontal. The average ambient temperature during April was 47°F as compared with the long-term average for April of 49°F.

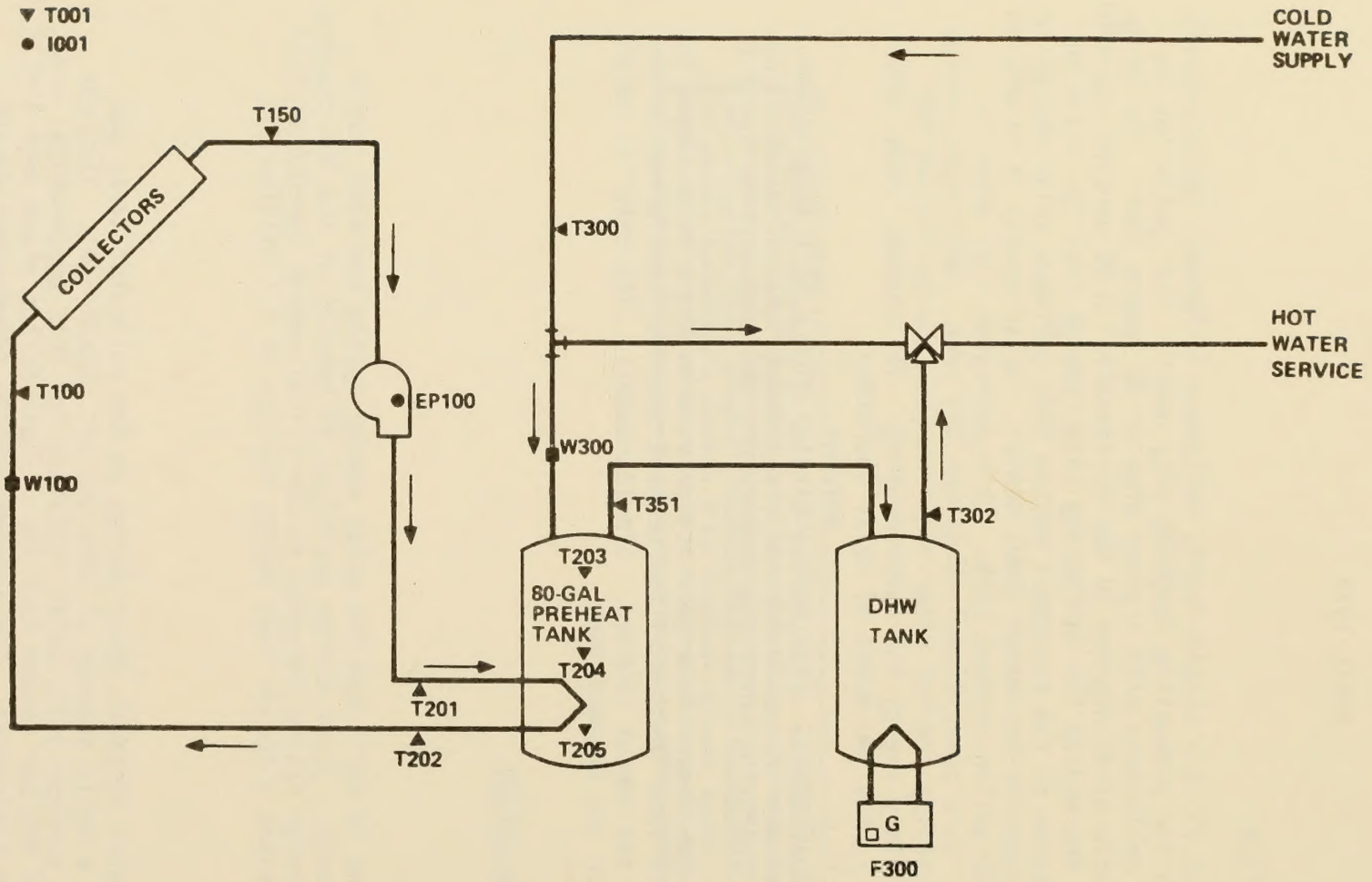


Figure 1. SADDLE HILL TRUST, LOT NO. 73 SOLAR ENERGY SYSTEM SCHEMATIC

THERMAL PERFORMANCE

System - During April the solar energy system performed somewhat poorer than expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as inputs. Solar energy collected was 1.0 million Btu versus an estimated 0.77 million Btu. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 0.64 million Btu. System total solar fraction was 45 percent versus an estimated 53 percent.

Collector - The total incident solar radiation on the collector array for the month of April was 1.7 million Btu. During the period the collector loop was operating, the total insolation amounted to 1.5 million Btu. The total collected solar energy for the month of April was 1.0 million Btu, resulting in a collector array efficiency of 59 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 0.91 million Btu. Energy loss during transfer from the collector array to storage was 0.09 million Btu. This loss represented 9 percent of the energy collected. Operating energy required by the collector loop was 0.14 million Btu.

Storage - Solar energy delivered to storage was 0.91 million Btu. There were 0.64 million Btu delivered from storage to the DHW subsystem. Energy loss from storage was 0.26 million Btu. This loss represented 29 percent of the energy delivered to storage. The storage efficiency was 71 percent: This is calculated as the ratio of the sum of the energy removed from storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 82°F.

DHW Load - The DHW subsystem consumed 0.64 million Btu of solar energy and 1.3 million Btu of auxiliary fossil fuel energy to satisfy a hot water load of 1.3 million Btu. The solar fraction of this load was 45 percent. Losses from the DHW subsystem were 0.19 million Btu. A daily average of 61 gallons of DHW was consumed at an average temperature of 131°F delivered from the tank.

OBSERVATIONS

Part of the 0.19 million Btu loss in the DHW subsystem was probably used to maintain tank temperature.

ENERGY SAVINGS

The solar energy system provided a fossil fuel energy savings of 1.1 million Btu, while incurring an electrical energy expense of 0.14 million Btu.

III. ACTION STATUS

No action is planned at this time.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/04
REPORT PERIOD: APRIL,1979

SITE/SYSTEM DESCRIPTION:
THE SADDLE HILL TRUST, LOT #73 SOLAR ENERGY SYSTEM FURNISHES HOT WATER YEAR-ROUND TO A SINGLE FAMILY DWELLING. THE COLLECTOR IS A TWO-PANEL LIQUID COLLECTOR. STORAGE SPACE IS AN 80 GALLON WATER TANK. AUXILIARY HOT WATER IS PROVIDED BY A GAS HOT WATER HEATER.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	1.680 MILLION BTU
	37325 BTU/SQ.FT.
COLLECTED SOLAR ENERGY	0.989 MILLION BTU
	21984 BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	47 DEGREES F
AVERAGE BUILDING TEMPERATURE	N.A. DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.38
ECSS OPERATING ENERGY	0.139 MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.139 MILLION BTU
TOTAL ENERGY CONSUMED	2.477 MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.266	N.A.	N.A.	1.266 MILLION BTU
SOLAR FRACTION	45	N.A.	N.A.	45 PERCENT
SOLAR ENERGY USED	0.643	N.A.	N.A.	0.643 MILLION BTU
OPERATING ENERGY	N.A.	N.A.	N.A.	0.139 MILLION BTU
AUX. THERMAL ENERGY	0.809	N.A.	N.A.	0.809 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FOSSIL FUEL	1.349	N.A.	N.A.	1.349 MILLION BTU
ELECTRICAL SAVINGS	N.A.	N.A.	N.A.	-0.139 MILLION BTU
FOSSIL SAVINGS	1.072	N.A.	N.A.	1.072 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.699

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/04
REPORT PERIOD: APRIL,1979

SITE/SYSTEM DESCRIPTION:
THE SADDLE HILL TRUST, LOT #73 SOLAR ENERGY SYSTEM FURNISHES HOT WATER YEAR-ROUND TO A SINGLE FAMILY DWELLING. THE COLLECTOR IS A TWO-PANEL LIQUID COLLECTOR. STORAGE SPACE IS AN 80 GALLON WATER TANK. AUXILIARY HOT WATER IS PROVIDED BY A GAS HOT WATER HEATER.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	1.772	GIGA JOULES
	423858	KJ/SQ.M.
COLLECTED SOLAR ENERGY	1.044	GIGA JOULES
	249653	KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	8	DEGREES C
AVERAGE BUILDING TEMPERATURE	N.A.	DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.38	
ECSS OPERATING ENERGY	0.146	GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.146	GIGA JOULES
TOTAL ENERGY CONSUMED	2.613	GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL	
LOAD	1.335	N.A.	N.A.	1.335	GIGA JOULES
SOLAR FRACTION	45	N.A.	N.A.	45	PERCENT
SOLAR ENERGY USED	0.679	N.A.	N.A.	0.679	GIGA JOULES
OPERATING ENERGY	N.A.	N.A.	N.A.	0.146	GIGA JOULES
AUX. THERMAL ENG	0.854	N.A.	N.A.	0.854	GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A.	GIGA JOULES
AUX. FOSSIL FUEL	1.423	N.A.	N.A.	1.423	GIGA JOULES
ELECTRICAL SAVINGS	N.A.	N.A.	N.A.	-0.146	GIGA JOULES
FOSSIL SAVINGS	1.131	N.A.	N.A.	1.131	GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.699

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/04
REPORT PERIOD: APRIL,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.015	44	0.008	N	0.002	N	0.561
2	0.005	37	0.009	O	0.000	O	1.784
3	0.015	42	0.002	T	0.004	T	0.141
4	0.045	38	0.014		0.005		0.319
5	0.016	40	0.009	A	0.002	A	0.532
6	0.063	38	0.018	P	0.005	P	0.279
7	0.052	37	0.018	P	0.006	P	0.349
8	0.110	41	0.027	L	0.006	L	0.247
9	0.005	34	0.033	I	0.000	I	6.191
10	0.047	39	0.006	C	0.006	C	0.131
11	0.111	47	0.042	A	0.007	A	0.380
12	0.096	49	0.028	B	0.006	B	0.294
13	0.082	39	0.018	L	0.004	L	0.223
14	0.011	37	0.032	E	0.000	E	2.814
15	0.022	40	0.004		0.005		0.184
16	0.017	40	0.007		0.004		0.432
17	0.051	43	0.019		0.005		0.377
18	0.081	44	0.015		0.006		0.184
19	0.062	42	0.014		0.005		0.235
20	0.097	46	0.052		0.006		0.532
21	0.107	48	0.018		0.006		0.173
22	0.060	53	0.023		0.005		0.385
23	0.102	61	0.037		0.006		0.367
24	0.099	60	0.037		0.006		0.374
25	0.056	58	0.027		0.006		0.474
26	0.055	62	0.017		0.006		0.312
27	0.009	60	0.026		0.002		2.727
28	0.066	62	0.021		0.006		0.319
29	0.036	58	0.020		0.005		0.527
30	0.084	63	0.039		0.007		0.466
SUM	1.680	-	0.643	N.A.	0.139	N.A.	-
AVG	0.056	47	0.021	N.A.	0.005	N.A.	0.383
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 0205SOLAR/1039-79/04
REPORT PERIOD: APRIL,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.015	0.006	0.004	44	0.276
2	0.005	0.000	0.000	36	0.000
3	0.015	0.010	0.007	47	0.451
4	0.045	0.039	0.024	45	0.521
5	0.016	0.009	0.006	45	0.368
6	0.063	0.055	0.037	48	0.593
7	0.052	0.045	0.026	43	0.503
8	0.110	0.103	0.069	52	0.628
9	0.005	0.000	0.000	33	0.000
10	0.047	0.042	0.027	45	0.576
11	0.111	0.105	0.069	61	0.623
12	0.096	0.090	0.060	64	0.632
13	0.082	0.078	0.052	47	0.630
14	0.011	0.000	0.000	38	0.000
15	0.022	0.018	0.010	46	0.450
16	0.017	0.011	0.005	43	0.309
17	0.051	0.045	0.032	58	0.626
18	0.081	0.072	0.048	57	0.594
19	0.062	0.051	0.030	58	0.486
20	0.097	0.086	0.059	59	0.610
21	0.107	0.098	0.069	64	0.644
22	0.060	0.052	0.029	69	0.476
23	0.102	0.096	0.069	80	0.673
24	0.099	0.092	0.064	78	0.639
25	0.056	0.051	0.035	70	0.623
26	0.055	0.050	0.032	72	0.589
27	0.009	0.005	0.002	60	0.245
28	0.066	0.063	0.046	73	0.695
29	0.036	0.033	0.022	65	0.610
30	0.084	0.081	0.056	77	0.667
SUM	1.680	1.487	0.989	-	-
AVG	0.056	0.050	0.033	56	0.589
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 0205SOLAR/1039-79/04
REPORT PERIOD: APRIL,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.004	0.008	-0.005	65	0.983
2	0.000	0.009	-0.007	54	1.000
3	0.007	0.002	0.006	55	1.136
4	0.022	0.014	0.003	68	0.806
5	0.006	0.009	-0.002	60	1.096
6	0.038	0.018	0.012	70	0.786
7	0.024	0.018	0.000	76	0.798
8	0.062	0.027	0.018	95	0.731
9	0.000	0.033	-0.037	69	1.000
10	0.024	0.006	0.017	62	1.002
11	0.065	0.042	0.003	88	0.690
12	0.054	0.028	0.012	91	0.745
13	0.044	0.018	0.011	105	0.652
14	0.000	0.032	-0.039	88	1.000
15	0.010	0.004	0.008	59	1.132
16	0.006	0.007	-0.001	63	1.065
17	0.030	0.019	0.002	71	0.722
18	0.045	0.015	0.019	82	0.752
19	0.026	0.014	0.001	99	0.607
20	0.053	0.052	-0.018	97	0.635
21	0.063	0.018	0.029	95	0.756
22	0.024	0.023	-0.014	111	0.383
23	0.062	0.037	0.007	99	0.712
24	0.057	0.037	-0.000	111	0.646
25	0.033	0.027	-0.004	97	0.679
26	0.031	0.017	0.003	97	0.648
27	0.003	0.026	-0.027	80	-0.344
28	0.044	0.021	0.010	80	0.713
29	0.021	0.020	-0.001	77	0.875
30	0.051	0.039	-0.004	84	0.693
SUM	0.906	0.643	0.001	-	-
AVG	0.030	0.021	0.000	82	0.711
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/04
REPORT PERIOD: APRIL,1979

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.029	39	0.008	N	0.029	N	0.049	N	0.014	46	134	41
2	0.057	25	0.009	O	0.056	O	0.094	O	0.015	48	139	75
3	0.026	11	0.002	T	0.032	T	0.053	T	0.004	57	136	34
4	0.039	21	0.014		0.034		0.057		0.024	50	132	56
5	0.033	27	0.009	A	0.030	A	0.050	A	0.014	53	134	47
6	0.065	21	0.018	P	0.057	P	0.096	P	0.029	52	138	87
7	0.040	32	0.018	P	0.033	P	0.054	P	0.031	50	131	57
8	0.054	37	0.027	L	0.029	L	0.048	L	0.045	49	131	75
9	0.067	49	0.033	I	0.046	I	0.077	I	0.056	51	131	96
10	0.056	17	0.006	C	0.062	C	0.103	C	0.010	53	136	73
11	0.052	45	0.042	A	0.016	A	0.026	A	0.070	49	131	73
12	0.038	66	0.028	B	0.012	B	0.020	B	0.047	47	129	57
13	0.024	63	0.018	L	0.013	L	0.022	L	0.031	57	126	34
14	0.048	59	0.032	E	0.028	E	0.046	E	0.053	54	125	70
15	0.024	40	0.004		0.027		0.046		0.007	48	133	34
16	0.036	25	0.007		0.034		0.057		0.012	53	136	47
17	0.058	24	0.019		0.050		0.083		0.032	49	134	80
18	0.037	32	0.015		0.025		0.042		0.025	47	136	51
19	0.022	39	0.014		0.012		0.019		0.024	48	131	33
20	0.064	55	0.052		0.018		0.030		0.086	51	127	95
21	0.036	60	0.018		0.026		0.043		0.031	51	131	50
22	0.024	71	0.023		0.000		0.000		0.039	51	120	41
23	0.053	68	0.037		0.023		0.038		0.062	53	125	79
24	0.038	81	0.037		0.006		0.010		0.062	55	123	63
25	0.030	84	0.027		0.006		0.011		0.045	52	125	48
26	0.028	66	0.017		0.013		0.022		0.029	52	129	42
27	0.048	56	0.026		0.029		0.048		0.043	54	131	72
28	0.041	47	0.021		0.023		0.039		0.035	52	132	63
29	0.040	50	0.020		0.025		0.041		0.033	53	128	59
30	0.056	64	0.039		0.015		0.025		0.065	53	130	90
SUM	1.266	-	0.643	N.A.	0.809	N.A.	1.349	N.A.	1.072	-	-	1820
AVG	0.042	45	0.021	N.A.	0.027	N.A.	0.045	N.A.	0.036	51	131	61
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/04
REPORT PERIOD: APRIL,1979

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATUPE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	328	N	44	44	N	N	N
2	115	O	37	36	O	O	O
3	334	T	42	47	T	T	T
4	1006		38	45			
5	364	A	40	45	A	A	A
6	1399	P	38	48	P	P	P
7	1165	P	37	43	P	P	P
8	2441	L	41	52	L	L	L
9	120	I	34	33	I	I	I
10	1042	C	39	45	C	C	C
11	2466	A	47	61	A	A	A
12	2125	B	49	64	B	B	B
13	1825	L	39	47	L	L	L
14	251	E	37	38	E	E	E
15	485		40	46			
16	383		40	43			
17	1132		43	58			
18	1790		44	57			
19	1369		42	58			
20	2160		46	59			
21	2369		48	64			
22	1344		53	69			
23	2262		61	80			
24	2210		60	78			
25	1253		58	70			
26	1220		62	72			
27	209		60	60			
28	1472		62	73			
29	810		58	65			
30	1876		63	77			
SUM	37325	N.A.	-	-	-	-	-
AVG	1244	N.A.	47	56	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

☆ U.S G.P.O. 1979—640-189/4207